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USSR Report

MACHINE TOOLS AND METALWORKING EQUIPMENT

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USSR REPORT

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TECHNOLOGY PLANNING AND MANAGEMENT AUTOMATION

START UP PROBLEMS AT MODERNIZED MACHINEBUILDING PLANTS

Moscow SOVETSKAYA ROSSIYA in Russian 21 Jul 84 p 3

[Letters: "Delay is Like Faulty Work"]

[Text] The replacement of traditional methods for working metal by more modern technology is a major reserve for accelerating progress in all machine building sectors. However, this transition is hindered because the machine tool building industry is not yet producing enough of the essential equipment. This was, in particular, discussed in the article "Strategy of Machine Tool Builders" (SOVETSKAYA ROSSIYA, 14 January 1984). The paper criticized Minstankoprom [Ministry of the Machine Tool and Tool Building Industry] for extremely unsatisfactory use of capital investments for production development of the most progressive machines. The slow projects were named. What has changed after this article?

Preparing for Start-up

[Letter by L. Aleynik from Ruzayevka]

A large plant for automatic sheet metal stamping lines is being build in Mordovia, close to the railroad center at Ruzayevka. The enterprise's future output will be modern means of production for items made from sheet metal of various thicknesses. The automatic lines will use technology making it possible to operate without people present. The start up of the first complex is intended for September. It is now time for installation. USSR Minmontazhspetsstroy [Ministry of Installation and Special Construction Work] units are now going out onto the "front lines". V. Lushenkov, chief engineer at the Saransk Administration of the Volgoneftekhimmontazh [Volga Petroleum and Chemical Enterprise Installation] Trust, explains:

"Together with collectives from Mordovstroy [Mordovian Construction] Trust, we had intended to stick to the schedule. The difficulties which previously delayed work have now been overcome. The construction of the administrative and service building, the transport shop, water supply and other facilities is under way on a broad front."

Workers are getting ready to install machine tools in the start up complex of auxiliary shops. Here they will begin to build unstandardized equipment and

parts necessary for the installation of neighboring shops. According to specialists' calculations, this will accelerate the construction of other objects at the plant. Foundations for a large vertical boring mill are already complete. Zabolotniy's installation brigade, well known in Mordovia, is entrusted with the assembly of this giant. The progressive collective decided to handle the task within shorter deadlines. The building housing the new plant boiler is nearby. Brigades from the Energotekhmontazh [Power Engineering Installation Trust] are working at full speed. They promise that everything will be ready by the day the complex is to start.

However, such changes are not evident everywhere. For example, since last year two almost complete mazut storage tanks, capable of holding 3,000 cubic meters each, have been awaiting completion. Although they were erected within the set deadlines, the installation workers cannot test them. The plant management cannot decide where to lay the pipelines. This delay at the project is only an unfortunate exception.

Soon the plant housing settlement will be ready for newcomers. Towers for cables and heat supply lines are now being built by V. Kuznetsov's comprehensive brigade. The collective is working on brigade contract, using progressive methods: components are initially assembled and tested on special stands, the completed towers are then hauled to the line, where tilting them up is the only thing left to do.

Party and soviet organs and patrols [dozorniy] from the autonomous republic are paying great attention to the site. With their concerned participation disruptions are straightened up without delay. The work is organized so that builders will not loose time coordinating activities.

A Facility Among the Weeds

[Letter by V. Pletneva, member, City Committee for People's Control]

There are weeds all around it. Trees are growing up, in spite of cutting. Above them are girders brown with rust. The uncompleted and abandoned building is called the Forge and Stamping Shop for the Salsk Forge and Press Equipment Plant.

I remember the spring day in 1970 when the first brick was ceremoniously laid while an orchestra played. At a meeting there was talk of the future size of things: 61 million rubles had been allocated for reconstruction and the enterprise would annually produce 10,000 forge and press machines. It seemed beneficial not only to the plant, but to the city. The builders promised that in addition to production facilities they would build a professional-technical school, several houses and kindergartens. Two large ministries, USSR Minstankoprom and USSR Mintyazhstroy [Ministry of Heavy and Transport Machine Building] were engaged in this work. A construction administration was set up especially for reconstruction work in Sal'sk. Initially things didn't go so badly, but then....

After 4 years 4 bays of 12 had been built for the first shop. In order not to fall behind the plan, the plant had to work "bay by bay" and open up this

building. Now, after all these ordeals, the plant is in operation, assembling 4,500 machines annually. In other words, it is producing only half of its planned output. But at what a price! The machine tools are so close together a mouse couldn't run between them. What about the two other shops?

In March 1980 Minstankoprom issued a strict order to complete the Salsk Plant's reconstruction during the 11th Five-Year Plan. USSR Mintyazhstroy was newly designated as the general contractor. Starting at that time, the plant accumulated a file which R. Kostan'yan, deputy director for construction, justifiably calls a chronicle of failed hopes. A huge correspondence, minutes of various meetings, from superintendents' to ministerial ones, these papers contain all sorts of answers and evasions! Glavsevkavstroy [North Caucasus Construction MA] demonstrates special skill at this. For example, in February 1983 the client asked for a work volume of 1.2 million rubles so that in accordance with USSR Gosplan decisions the forge and press shop would be finally introduced. The administration agreed to only 500,000 rubles. A month later it gave notice that due to the heavy work load for SU-105 [Construction Administration], it would not be able to build anything. Finally, it dealt the conclusive blow. Administration managers reported that in 1985 it would not be able "to take the start up complex under consideration".

Minstankoprom and Mintyazhstroy managers should keep in mind their signatures on the joint order. After all, the deadline for introducing the shop has already been doubled over that intended by USSR Gosplan and has again been openly ignored. Also, Minstankoprom is lagging and asking that capacity introduction be eliminated from the 1983 plan because the builders' sluggishness has prevented the client from installing equipment. Then came the instructions: "Jointly examine and take the necessary measures to assure the introduction of production capacity foreseen by the 1983 plan." However, the builders did not appear at the project and they don't plan to be there next year either.

In 14 years SU-105 has had 6 leaders and the number of workers in the basic professions has declined almost 3 fold. Why can't they retain the collective? Guilt here not only belongs to Glavsevkavstroy managers, but also to oblast organizations which, having promised the administration an entire series of orders, were not concerned about their social development.

One can understand the attitude of Academician B. Ye. Paton, director of the Electric Welding Institute. He uneasily wrote to USSR Gosplan about disruptions in the construction of new capacity at the Salsk Plant. The enterprise should have been able to meet the sector's needs for semi-finished parts for 10,000 presses 3 years prior to the established deadline. This deadline has now passed and there is no end in sight to the damage which the slow project is causing to the national economy.

The Salsk Plant is now producing the sixth modification of a press, robots, manipulators, mechanized and automated lines. Their competitiveness is such that every 10th machine is being exported. They are purchased by 25 nations, including England, France, Japan, Canada and the FRG. As can be seen, the enterprise is neck and neck with progressive ones. When the builders finally give the shop "keys" to the client their technology should not be obsolete. It would be necessary to again start reconstruction.

[From the Editors:]

We remind you: The CPSU Central Committee has put special urgency upon the problem of accelerating scientific and techical progress, above all in machine building. This task will to a great extent be solved through the creation of the most modern machine tool construction base. Therefore, approving the changes at the Ruzayevka start up complex, we want to direct the attention of managers of USSR Minstankoprom and USSR Mintyazhstroy and of party and soviet organs in Rostov Oblast to the sad state of affairs at the construction of the new shop at the Salsk Forge and Press Equipment Plant.

11574
CSO: 1823/27

MODERNIZATION THROUGH TECHNOLOGY AUTOMATION URGED

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 5, May 84 pp 1-2

[Article by B. V. Karpov, Chief, SOYOZSISTEMPROM, All-Union Production Association: "New Tasks in Automated Control Systems"]

[Text] The June 1983 plenum of the CPSU Central Committee determined that a fundamental increase of worker output is the nation's key economic problem. An important factor in achieving greater worker output is automation of industry based on wide use of computers and robots and the introduction of versatile technologies that will make it possible to rapidly and efficiently convert production lines to the manufacture of different products.

The technological re-equipment of many sectors of Soviet industry has been aimed at increasing industrial output, saving material and manpower resources and improving product quality by means of improving technological equipment, automating processes and creating automated machinery, production line and shops. This re-equipment of Soviet industry has determined new tasks and goals that must be considered in creating automated control systems.

The main purpose for developing automated control systems is to provide a sharp increase in production efficiency. This can be achieved by comprehensive automation of production and control systems, by product design processes and by employing technologies based on the wide use of modern computer technology.

The instrument-building industry's scientific and technological goal-oriented comprehensive programs have been aimed at solving the following problems:

--creation and introduction of flexible automated processes (GAP);

--development and introduction of automated technological process control systems (ASUTP);

--creation and introduction of automated design systems (SAPR);

--improvement of the organizational structure of control systems.

In 1983, almost 40 percent of the machine-building industry's firms were working on projects to create new automated control systems and to improve existing ones. This work provided a savings of about 10 million rubles in production costs.

The comprehensive automated control system introduced at the production association of the K.N. Rudnev Control Computer Plan in Orel controls production within the entire plant, between shops and within the individual shops. It also controls technological processes. The system is organized for multiterminal dialogue between users and the system computer. The introduction of this system has resulted in a yearly savings of 1.3 million rubles. Costs for the preparation of technological documentation were reduced 15-20 percent. At the Kiev Tochelektropribor Production Association, the Krasnodar Measurement Instrucments Factory Production Association, the Smolensk Iskra Production Association, the Vinnitsa Terminal Production Association and many other enteprises 36 automated control systems for technological production processes have been introduced. These systems have reduced the laborintensiveness of technological operations and increased both the objectivity of process monitoring and product quality.

In order to improve the technological and economic level of products, technologies and automated systems and to reduce the manpower time spent on development, 40 automated design systems were introduced in 1983. Some of the enterprises receiving the new systems were the Vibrator Production Association, the Lvov Pribor and Starorusspribor [not further identified], plants, the Vibropribor Production Association, the Soyuz Production Association, etc.

The most important tasks to be confronted in automated design systems are the calculation and design of blocks,units, mechanisms, machines and instruments and the design of specific articles, technological processes and control systems.

Industry's assimilation of new items in a short amount of time and the wide range of production require an entirely new approach to the organization of production processes. Such a new approach would make it possible to considerably increase work productivity, improve the rhythm of production operations, make fuller use of equipment and also lower the amount of time and manpower lost on auxiliary operations. In connection with this, preference is given to equipment that is most adaptable to a change in the type of machine parts being produced (equipment with digital program control based on aggregate-module designs).

Particular attention is being paid to the difficult task of creating comprehensive automated processes oriented to the production of specific items and, above all, the creation of production systems most adaptable to frequent changes of production items, in other words, systems of adaptable automated production.

Adaptable automated production is a set of equipment used for programming, specification reprogramming, technological processes, transport and storage. All of this equipment is united within a single common control system designed to carry out automated production of items of altered design or series production while maintaining their technological similarities.

Adaptable automated production includes equipment (groups of machine tools with data-processing digital program control), a transport system, automatic storage with stackers, working space for loading and unloading of parts, a division for assembly of attachments, an instrument preparation division and an automated control system.

The automated control system manages the digitally-programmed machine tools, the transport system, blank storage, the production preparation section and workplaces at loading and unloading stations. It can also automate planning and computation of production, dispatching and equipment control, controls equipment and instrument maintenance in real time mode and prepares and distributes control programs.

The use of adaptable automated production does not only increase work productivity 8-10 times but is also considerably alters the nature of production. The Ministry of Instrument Production is developing a program for creating adaptable automated machine tooling and parts assembly. According to this program, adaptable automated machine tooling will be introduced at the Mogilev Tekhnopribor Works and the experimental Tekhnopribor Testing Plant at Ramensk.

At the same time, VPO Soyuzsistemproma is creating under a joint program automated control systems for the adaptive automated production system of Minstankoprom's factories. In 1982, the Ivanov Heavy-Duty Machine Tools Plant imeni 50th Anniversary of USSR received an automatic control system for its Talka-500 adaptable automated production line and the automated production line at the Ulyanovsk Heavy-Duty and Specialized Machine Tools Plan received an automatic control system in 1983.

Thus, new designs for automatic technological process control systems, automatic design systems and adaptable automatic production lines continue to hold an important place in the field of production discrete control systems.

12261
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IMPACT OF NEW FORGE-PRESS TECHNOLOGY ON MANPOWER

Moscow PRAVDA in Russian 22 Aug 84 p 2

[Article by V. Karzhan, director, All-Union Scientific Research Institute of Forge-and-Press Machinebuilding, candidate of technical sciences, and N. Deordiyev, professor, Voronezh: "Robot Needs Work; Routes of Technical Progress"]

[Text] It is not the first year that forge-and-press equipment has been produced in the shops of the Voronezh Production Association imeni M.I. Kalinin. Its main advantage is that the automated lines are "interfaced" with manipulators and robots. These systems make it possible to increase by a large factor labor productivity in forge-and-press production.

But here is the problem: It would appear that the irreplaceable "smart" machines, which have considerably reduced the number of people involved in this process, in a number of cases have not found employment. They are acquired, but often they are not used. PRAVDA has already written about these alarming facts of "robotophobia" on 8 December 1983, in the article titled "Extend a Hand to a Robot."

It must be said that little has changed for the better since then. It seems that not only has the psychological barrier stood in the way of mastering this latest technology. Production lines are often so highly productive that a specific enterprise's schedule for them is simply peanuts. So what is to be done?

Advance-preparation press forging production is very labor intensive and complicated. It remained just to dream of the day when a continuous chain of machines would take this process entirely on itself and would free man from heavy monotonous work, at the same time guaranteeing high quality of the final product. It would be possible to gradually phase out both machining and casting as far less efficient operations.

Mechanized and automated systems and lines capable of performing practically all processes in working a material have been shipped from Voronezh to all ends of the country. This includes cutting rolled stock, cold and hot stamping, forge rolling, producing products from metal powders and plastics,

compacting refractory materials, briquetting and packaging asbestos, cotton, wool and waste paper. How many "trades!"

But here is the bad news: The enterprises which have ordered and received this equipment use the systems only partly; not infrequently they shut off the automatic equipment and robots or they stop them altogether. What is happening? The Voronezh machines as a rule perform reliably. It turns out that the majority of enterprises are not in a position to utilize them even at a quarter of their capacity. The machines are forced to stand idle; the money spent for them is not recovered. And, you see, they are required to use them, if things are to be viewed managerially, not less than one and a half to two shifts. The question suggests itself: How to achieve this? There is an answer. It is necessary to concentrate press forging production, to concentrate the production of the same kinds of forgings, stamped products and other products at large plants or in specialized shops.

It has been calculated that at enterprises at which the annual amount of hot forgings exceeds 20,000 tons the output of them per single worker by means of automatic lines is 20 times higher than at enterprises with an amount of forgings produced of up to 100 tons. There is a saving for you. In addition, in the first instance the production cost for a ton of the product is four times less.

Numbering among enterprises and associations at which lines and systems are used, it may be said, with a maximum return are the Volga and Minsk automobile plants, the Minsk Tractor, the Lozovaya Mechanical Forging and the Tokmak Press Forging plants, and other enterprises. Even the very name of some of them says that large-scale and mass production of such a profile have taken shape there. But what is to be done if the percentage of such enterprises in the country is not so high? In the majority they are machine building plants--medium-size and small ones. Is it possible that their fate is to use a technology which has outlived its time?

We will not rush. Firstly, let us direct our attention to the fact that enterprises which are "not giants" are still in the majority. But in the total extent of the production of the same forgings they are all the more "outweighing" the heroes. So is it possible that the lion's share of products must be produced by inefficient methods? The next conclusion automatically suggests itself: Small enterprises must be totally satisfied with stock from large plants. They have to obtain it through cooperation from specialized interindustry enterprises and interindustry production bases. In which connection, under conditions of planned socialist management of the economy we have every objective opportunity to solve this problem at the highest technical and economic level. For this purpose it is necessary to arrange for the consolidated production of press forged products and to bring it as close as possible to their major consumers, taking into account also the reduction in transportation expenses and shortening of delivery times.

Domestic and foreign experience testify also to the advisability of thorough specialization in the production of a specific kind of part. But our

enterprises hitherto have been characterized by an orientation toward the production of a long list of products which differ in terms of their production process. Where is automated press forging equipment to be used here?

An extremely undesirable "two-pronged" situation appears. On the one hand, Minstankoprom [Ministry of the Machine Tool Building and Tool Making Industry] has mapped out and is carrying out a program for the production of automated equipment which meets the requirements of the time and the development of technical progress, and on the other, the very organizational conditions for the application of the new equipment are holding back the use of advanced technologies, thereby reducing the demand for this equipment. Industry is ordering only in very small quantities automatic systems for cold forging. At the same time, however strangely, industry continues to experience a need for general-purpose non-automated equipment. In this connection, a number of industries have been forced to develop, though in a certain sense primitive, but their own, press building, often duplicating Minstankoprom and one another. In a word, the route taken in practice does not appear to be the most efficient one.

We foresee a question: Perhaps, the Ministry of the Machine Tool Building and Tool Making Industry, as the arbiter in the development and production of press forging equipment, should reorient itself and consider producing small or less productive lines? No, this would be a step backward. And besides, in the overwhelming majority of cases it is impossible to act in this manner for the same technical reasons--automatic equipment does not work slowly.

It remains to raise and to improve the level of the specialization and concentration of production. All the more so because the very dispersal of shops and sections for the production of press tools, molds and tools is by no means conducive to improving the quality of these products and produces chaos and the inefficient distribution of materials for making equipment.

And so, what would we suggest be done specifically to solve so important a State problem? It seems that, in the national economy--primarily in machine building and metalworking--on account of the numerous small sections and shops under the jurisdiction of various departments, it is necessary to form as quickly as possible an independent branch for the production of stock, as well as a subbranch for the production of press tools, molds and tools. This does not require any additional physical and human resources--today much more effort and money are being spent on the formation of "private" blacksmith shops and foundries absolutely everywhere. It is necessary to form specialized interindustry sections and shops furnished with high-productivity automated lines and systems and able to provide for the demand of entire economic rayons and regions for press forging stock.

We believe it is absolutely not mandatory to concentrate the production of stock somewhere at a single place, necessarily at a large enterprise. It is possible to set up the production of a narrower list of products at areas which are free as the result of reorganization at a number of large enterprises. The narrow specialization of sections formed will considerably

facilitate, in our opinion, the solution of the organization problems involved in selecting and keeping highly skilled personnel. All the conditions will be created for the more efficient filling of orders. Robotization and flexible automated production processes in combination with an advanced resource-saving technology will be given extensive freedom. Press forging equipment will be used considerably better and consequently less of it will be required.

Of course, it will be necessary to wrack our brains over regulation of the working provisions for interindustry enterprises, shops and bases. Of course, direct communication with customers should predominate, and orders should be received only for products which the interindustry people are able to produce less expensively than the customers can themselves.

The only thing left to be added is that by the logic of things agencies of the USSR Gossnab could take upon themselves the functions of monitoring the operations of interindustry subdivisions and the placing of orders, and the local oblast planning administrations the planning of production volumes and the nomenclature. Of course, all the organization work relating to improving press forging production is in the power only of the USSR Gosplan and the USSR State Committee for Science and Technology.

8831
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INDUSTRY PLANNING AND ECONOMICS

BOOK ON UKRAINIAN MACHINE TOOL INDUSTRY NOTED

Kiev EKONOMIKA SOVETSKOY UKRAINY in Russian No 5, May 84 pp 90-91

[Article by V. Kochetkova, candidate of economic sciences: "Effectiveness of Equipment Base of Machine Building"]

[Text] Advances in machine building have foreordained the scale of retooling of all industries of the national economy. The increase in the role of machine building in the system of public production and ensurance of the unprecedented pace of its development in the future, too, have necessitated continuous improvement and an increase in the effectiveness of its equipment base. A study of the possibilities of solving this problem is the main goal of the book under review.* In it an attempt is made on the theoretical and practical plane to demonstrate the ever growing role of engineering and technology in the development of and improvement of the efficiency of modern production, and to study ways for and aspects of the development of the machine building complex and the influence of the industrial engineering level of machine building enterprises on the economic indicators of their work.

In the book the basic directions of the development of the machine building industry are discussed, methods are presented for evaluating the technical level of machine building production, aspects of the formation of the structure of the metalworking equipment inventory are discussed, and light is shed on experience in modernizing existing machines and units and on the effectiveness of the introduction of new production processes. Here the authors correctly point out (p 5) that under conditions of the modern scientific and technical revolution the problems of machine building have become more complicated and the requirements imposed on the industry with respect to the solution of economic and social problems have been heightened.

Based on the decisions of the 26th CPSU Congress with regard to improving the efficiency of production on the basis of its intensification in every way and of speeding scientific and technical progress, the authors define in the

*Pokropivnyy, S.F., editor. "Effektivnost' tekhnicheskoy bazy mashinostroyeniya" [Effectiveness of Equipment Base of Machine Building], Kiev, Tekhnika, 1981, 144 pages.

following way the strategic directions for the development of machine building: ensuring the fundamental newness of machines and improving their unit capacity and productivity; the development of systems of machines for the total mechanization and automation of production processes; reduction of the specific quantity of metal and the improvement of the life, reliability and durability of machines, equipment, apparatus and instruments produced; and improvement of the structure and forms of public organization of machine building production. These trends in the development of machine building reflect to the full extent scientific and technical progress in the field of producing the tools of labor and materials and of improving production processes, and determine the prospects for the longterm development of this industry.

The experience of many machine building enterprises and associations of the republic in forming an advanced structure for the equipment inventory, of modernizing it, and of using new production processes is generalized thoroughly and comprehensively. In addition, original and practically applicable techniques are contained here also for determining the effectiveness of the modernization of equipment and for selecting the most efficient version of a production process.

The potential for improving the efficiency of the work of production equipment, the role of specialization, concentration and cooperation in improving the utilization of equipment, and economic incentives for the efficient use of machinery and equipment are pointed out. The authors devoted much attention, and this is justified, to reasons for a low shift factor for operation of the machine inventory. One must agree with their view that the main reason for the low shift factor and the great amount of equipment downtime is not so much a shortage of machine tool operating personnel, although it does play a certain role, as shortcomings in the organization of production, the low technical and economic level of ancillary production, and the presence of a great amount of superfluous equipment.

The effectiveness of utilization of machine building's equipment base depends on a great number of factors of a technical, organization and economic nature. As demonstrated by experience which has been gained, the level of the utilization of the means of labor and the degree of the utilization of equipment are higher at those enterprises and associations where in addition to industrial engineering measures skillful use has been made of key economic factors and incentive systems. Such a highly important principle of socialist management as observance of the dialectical unity of engineering, technology, organization and the control of production finds its manifestation in this. A separate section (pp 133-139) is devoted to this question, where a discussion is presented of the experience of organizing the work of Minsel'khozmash [Ministry of Tractor and Agricultural Machine Building] and Minkhimmash [Ministry of Chemical and Petroleum Machine Building] with regard to more efficient utilization of the machine inventory.

The book could have been, in our opinion, even more interesting and helpful, if some of the problems discussed in it had been given fuller elucidation. For example, the effectiveness of the functioning of machines and equipment

depends to a greater extent on high-quality and timely repairs. However, repairs are talked about only sporadically (pp 116-119), while modernization, for example, the cost of which in the machine building industry of the Ukrainian SSR is approximately 10 times lower than the cost of repairs, has a separate section devoted to it. Nothing is said in the book about how the formation of production and scientific production associations has influenced the functioning of the machine inventory and the introduction of advanced technology.

Let us emphasize in conclusion that the individual shortcomings do not detract from the merits of the reviewed book as a whole. It is distinguished by a sufficiently high scientific level and extensive and carefully elaborated factual data. The book is helpful for a wide range of readers--engineering and technical personnel and economists at machine building enterprises, associations and ministries and at design and scientific research institutes.

8831
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HIGHLIGHTS OF METALWORKING EQUIPMENT EXHIBIT

Riga NAUKA I TEKHNIKA in Russian No 8, Aug 84 p 11

[Article by Y. Akots: "Metal Processing-84"]

[Text] This spring in Moscow more than 500 enterprises, organizations, and firms from many countries of the world showed their latest achievements in the area of equipment, instruments, and tools for the metal-processing industry. Such wide representation allowed the basic trends in the development of the field to be revealed.

Production of equipment with numerical programmed control and of machines that carry out a number of technological processes (the so-called processing centers) is becoming widespread. New processing technologies are being instituted: lasar, electrochemical, etc. Automation is being more and more widely introduced in small-scale production. All primary and auxilary processes are being robotized.

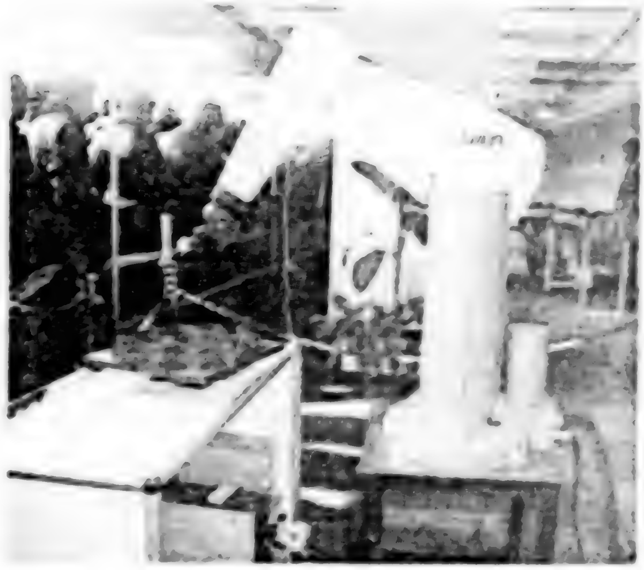
Our country's exposition was the most representative at the exhibit--about 300 displays, from machines for instrument making and the horological industry to equipment for the heavy and power engineering industries.

The flexible Talka-500 production system, developed at the Ivanovskiy machine-tool association imeni 50 years of the USSR, can be considered the best sample of the domestic machine-tool industry.

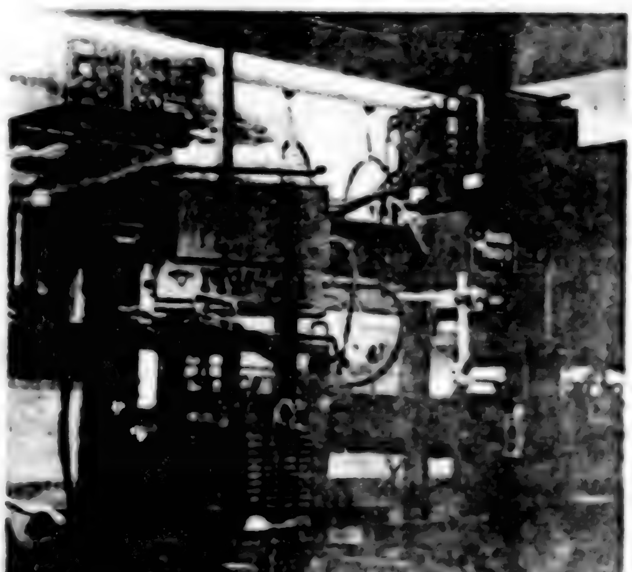
The processing centers developed jointly by specialists from the GDR and the USSR, the USSR and Czechoslovakia, and other joint developments of the SEV [Council of Mutual Economic Aid] are a graphic example of the advantage of socialist economic integration.

Mutually profitable cooperation among Soviet enterprises and western European firms served as the basis for the development, in particular, of the Finnish firm Nokia's industrial robots; a control system manufactured in the USSR is utilized in the robots.

The IR-800 boring machine from the Ivanovskiy industrial association of machine building



Industrial robots from the Finnish firm Nokia



Talka elastic automated production

12461
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ROBOTICS

CONTROL SYSTEMS FOR ROBOTIC PRODUCTION LINES

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 5, May 84 pp 4-5

[Article by L.Y. Lerner and V.R. Lifman: "The Creation of control systems for robotic lines with changed configuration"]

[Text] At this time, the Soviet Union has taken a course of intensive introduction of progressive technological processes that use industrial robots. Experience in robotization of industry has shown that the best results are given by robotic lines that are designed to manufacture a specific group of parts and operate under the same (similar) production processes. For example, with the production of parts by several presses working in sequence, it is not enough to limit the replacement of a stamp machine operator at the press with a robot to feed parts into the press. Since it is unnecessary for the robot to feed the parts into the press in a given position one at a time, as a rule, it makes sense to have it remove the parts from under the press as well and either pass them on for further treatment or stockpile them.

Such an approach to the problem of automation makes it possible to exclude interval manual stockpiling of the blanks and receive at the end of the metalworking cycle parts which are already packaged and ready. Therefore, the metalworking process can be further roboticized.

The main purpose of automation in this regard is to increase productivity and reduce "living" labor costs.

Any given method of automation is determined by the structure of the production process, the type of parts being produced on automated equipment and other such factors.

The following phases can be distinguished in the technological process of manufacturing machine parts (see Figure 1):

In most cases, the metalworking can be done on several machines since the transportation of parts from machine to machine, their installation and removal and sometimes even the interval storage of blanks with tracking of all of the routes taken by each part is a rather serious problem both technically and organizationally.

Aside from this, it is necessary to the normal functioning of the technological process to provide the following auxiliary functions:

IS -- instrument and equipment storage;

IT -- instrument and equipment transport;

II -- installation (change) of instrument and equipment;

QC -- quality control of the parts;

DI -- diagnosis of all systems;

M -- maintenance of all systems.

Therefore, it is necessary below to distinguish between the following control systems:

ASC -- systems for controlling automated storage of materials, blanks, parts, instruments and equipment;

TCS -- transport equipment control systems;

MCS -- materials handling control systems;

PCS -- metalworking process control systems;

QCS -- parts quality control systems;

DS -- systems for diagnosis of the technological state of the entire complex and equipment and the control system;

IRCS - instrument replacement control system.

The computations below must be performed for the following level of control:

-- the production of all parts of type;

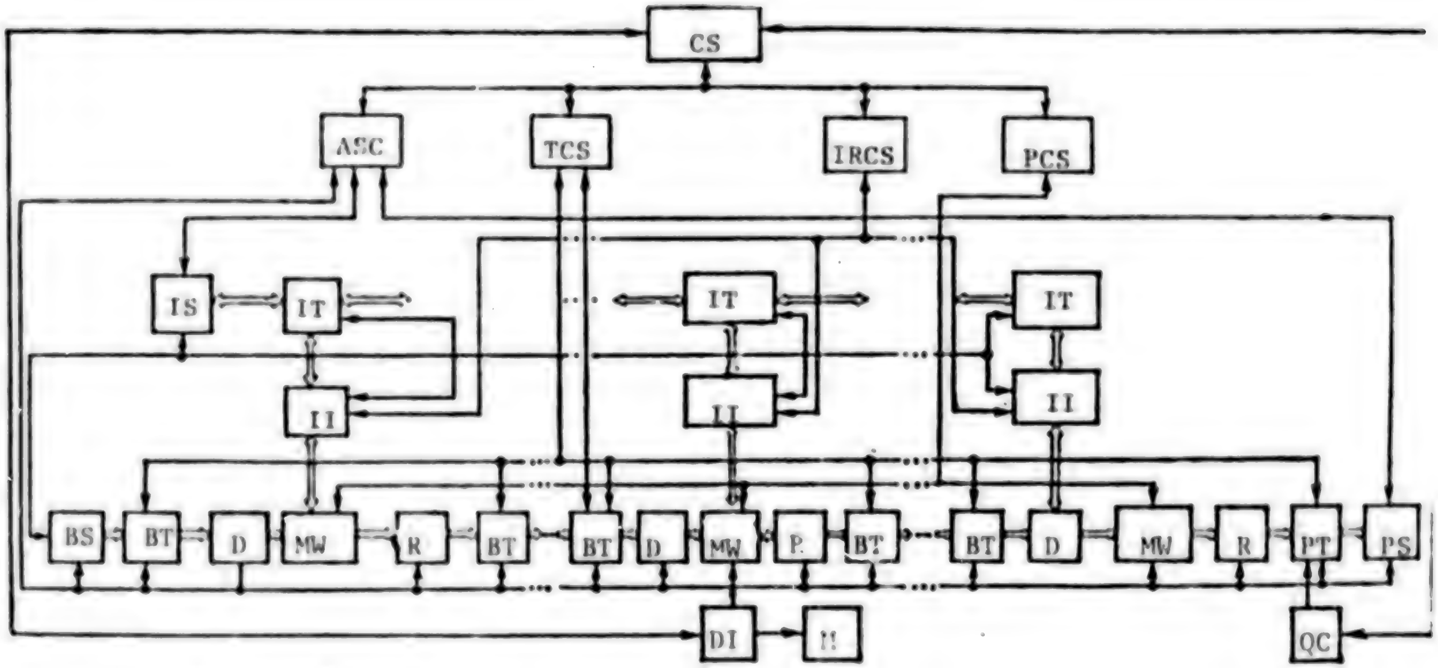
-- unfinished production;

-- instrument wear;

-- equipment work and downtime;

-- materials, blanks, instrument and equipment parts in storage;

-- packing.



— flow of materials

— flow of information

Figure 1. Structural scheme

BS -- blank (materials) storage;

BT -- blank (materials) transportation to the metalworking machine;

D -- delivery of the blanks (materials) to the metalworking zone;

MW -- metalworking (production of the machine parts);

R -- removal of the finished parts from the metalworking zone and their transfer by a transport system;

PT -- parts transportation;

PS -- parts storage.

If these problems are solved and a proper data base is available, the control system can perform the following signal forming and sending functions:

-- report on the performance of the shift (day's) work;

-- test the state of production at any given time;

-- check for the presence of unnecessary blanks (materials) in the stockpile;

-- check the service life of instruments and equipment;

-- check for instruments (equipment) in the stockpile which need replacement;

-- check for spoilage of all parts produced during the shift.

In connection with the fact that the control system is designed to operate under conditions small-lot production in which there is rather frequent change of produced parts and also considering that the sequenced linear operation of equipment lowers the readiness of the entire line, the system should provide quick rearrangement of the line configuration whenever one item of equipment malfunctions or there is a conversion to the production of other parts and quickly locate the point of malfunction.

At the Parma Scientific Production Combine, a control system for robotic lines was developed. The system is based on a SM-1800 minicomputer operating on real time and consisting of digital data input and output modules to which are connected pickups that monitor the condition of the technological control unit and the mechanisms controlling the robots and machines.

The introduction of this system makes it possible to solve a series of control problems (see figure 2):

-- coordinated real time control of groups of robotic technological complexes;

-- quick rearrangement of the production process's configuration during malfunctions, conversion to the production of other items, etc.;

-- detection of defects and the output of "advice" on how to eliminate them;

-- diagnosis of the storage system and the generation of signals preceding the completion of blanks in the feed storage;

-- metering the production, defects, work and downtime of the equipment;

-- recording the functioning modes (printing the "journal of work metered over one shift");

-- capacity to increase the number of operating shifts without added costs.

Figure 2

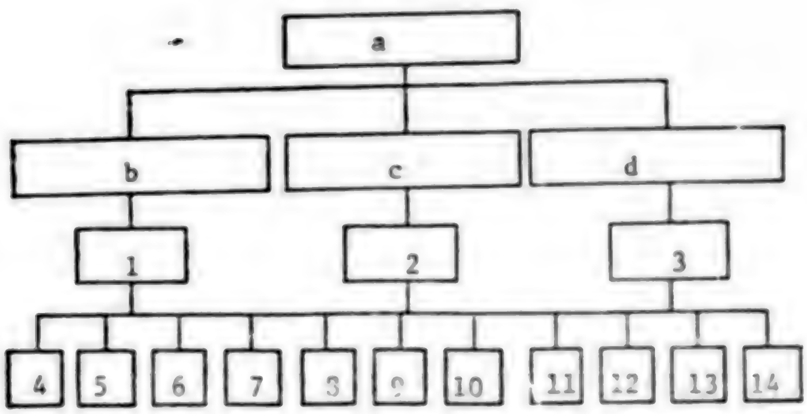


Figure 2. Scheme of a functional structure: 1. coordinated real time control of groups of robotic technological complexes; 2. diagnostic system; 3. metering and recording of function operation conditions; 4. linear grouping of robotic technological complexes; 5. line actuation control; 6. line cyclical operation control; 7. line shut-down control; 8. technological diagnosis of the controlled equipment; 9. technological diagnosis of the control system; 10. storage system diagnosis; 11. metering of production and check output; 12. metering of shut-do[illegible] nd issuance of checks; 13. metering of malfunctions

and issuance of checks; 14. the forming of a "meter" file and the printing of a "journal."

key: a. KEDR system; b. control functions; c. data-processing functions; d. auxiliary functions.

The concept of building a system for controlling robotic lines with altered configuration makes it possible to simultaneously implement real time control of several lines which is not at all critical to the composition of these lines (i.e. to the number of equipment units controlled at the given time). This therefore provides flexibility, i.e. quick change-over to the production of other items. For this purpose, it is sufficient to change the instrument and equipment (if necessary) and to introduce from themaster panel new configurations for the line and series numbers to the parts, actuate the line with the corresponding blanks at the input and then receive the other parts at the line's output.

The control system makes it possible to provide a high degree of "liveliness" to the object controlled. This quality consists of the object's ability to continue work under any component assembly malfunctions in a truncated manner and, thanks to the system of technological diagnosis, it will locate the point of defect in a minimum amount of time. If there occurs a malfunction somewhere within the complicated complex of technological equipment, the diagnosis system automatically indicates on the screen of the master panel the exact point and type of fault as well as "advice" on how to eliminate it that requires no specialized knowledge. Therefore, in order to maintain a complex object, there is no need for highly-qualified service personnel. The diagnostic system is adaptive, i.e., the object's diagnostic models may be corrected on the basis of accumulated experience.

Through a set of pickups, the control system monitors works and meters equipment downtime the production of each part the system turns out. At any moment, the system knows the number of parts in the storage, etc. All information about the state of production can be viewed on the master console display screen.

The standard VTA-2000 terminal of the SM-1800 minicomputer is used as the master console.

No special knowledge is required to establish communication between the master console and the control system therefore the entire system dialogue with the master console can be conducted in Russian with a question-and-answer format. If a false answer is given or any difficulty is encountered in dialogue, the system will give a prompt, i.e., a set of allowable answers.

A specialized operator is not needed for work with the VTA-2000 terminal.

At the end of a given shift, the printer gives a printout, "journal of equipment performance metering," that gives a complete picture of the work during that shift. This includes the work and downtime of the robotic lines, the unit by line and part produced, defects that have been found, etc. The console operator must only sign the journal at the end of his shift.

For communication with adjacent systems, all of the metered information is recorded on a floppy disc and can be reproduced in any form whenever needed.

The system described in this article has been introduced at Leningrad's Elektropribor Production Association to control three roboticized lines for stamping the output sockets for large integrated circuits.

12261
CSO: 1823/3

ROBOTICS

NON-AVAILABILITY OF CERTAIN ROBOTS REFUTED

Moscow EKONOMICHESKAYA GAZETA in Russian No 34, Aug 84 p 8

[Article by L. Snovskiy. chief of the department of Machine Tool Construction. USSR Gosplan: "Robot Technology In the Center of Attention"]

[Text] I looked with interest through the article by Riga director Yu.Ya. Kokto "At The Center Of Robot Technology", published in this year's first issue of EKONOMICHESKAYA GAZETA. I feel that the author advanced a number of urgent issues on the further development of domestic robot technology.

Actually, at the present time the overwhelming majority of industrial robots are used in the machine building and metal work production processes. Besides the reasons that the article's author indicated, this situation is explained by the fact that today the machine building industry does not have the required number of specialists in production automation based on industrial robots. This means that potential users in other than the machine building industries of the economy are isolated from the wide introduction of industrial robots that is taking place in both general and specialized machine building.

It is impossible to agree with the statement by the article's author that a number of potential users do not have the chance to order the required types of industrial robots. First, the well-known CPSU Central Committee and USSR Council of Ministers resolution on "Increased Production And Introduction Into The Economy Of Automated Manipulators With Programmed Control (industrial robots) In 1981-1985" determined the key ministries in developing, assimilating, producing and introducing industrial robots and equipment complexes equipped with them into the national economy. Resolving the indicated tasks for non-machine building industries was specifically entrusted to Minlegpishchemash [Ministry of Machine Building for Light and Food Industries and Household Appliances], Minkhimmash [Ministry of Chemical Machine Building], Minsel'khozmash [Ministry of Tractor and Agricultural Machine Building], Minzhivmash [Ministry of Machine Building for Animal Husbandry and Fodder Products], Minstroydormash [Ministry of Construction, Road and Municipal Machine Building] and other ministries. They are committed to working with robot development in accordance with their own specializations and according to the demands of other USSR ministries and departments.

Second, the sequence of industrial robot orders is determined by the 21 December 1982 USSR Gosplan [State Planning Committee] and USSR Gossnab [State

Committee for Material and Technical Supply] Resolution No. 290/107 entitled "The Sequence of Planning Production, Distribution and Delivery of Automated Manipulators with Programmed Control (industrial robots).

In regards to the development of methods for calculating the economic effectiveness from introducing robot technology, this year the All-Union "Instructions For Evaluating Economic Effectiveness From The Development And Use Of Automatic Manipulators With Programmed Control (industrial robots)" was approved by the GKNT [Council of Ministers State Committee for Science and Technology], the USSR Gosplan and the USSR Goskomtsen [State Committee on Prices]. In regards to questions posed by the article's author, in the area of planning and financing advisory support to production workers in completing pre-design and design work and also during the installation of industrial robots, the USSR Gosplan Department of Machine Building feels that the indicated work must be provided for in the plans of industry, inter-industry and regional scientific-technical and the systems programs developed in accordance with GKNT, USSR Gosplan, USSR AN [Academy of Sciences], USSR Gossnab, USSR Gosstroy [State Committee for Construction], USSR Minfin [Ministry of Finance] and the USSR TsSU [Central Statistical Directorate] Resolution Number 130/68 dated 30 March 1984.

The USSR Gosplan Department of Machine Building also considers it expedient to continue the exchange of opinions on issues related to the organization of the activities of regional and republic inter-industrial robot technology centers. This promotes the development and wide introduction of industrial robots.

12511
CSO:1823/74

PROCESS CONTROLS AND AUTOMATION ELECTRONICS

UDC Δ65.011.56.65:681.3:621:658.2

ULYANOVSK PLANT DEVELOPS FLEXIBLE CONTROL SYSTEM

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 5, May 84 pp 7-9

[Article by A.P. Martynov, engineer, and N.V. Kachan, candidate of economic sciences: "Flexible Automated Control System for System of Machine Tools with Numerical Program Control"]

[Text] A component of the development of automated sections and plants is the development of control systems for automated systems of machine tools with numerical program control under conditions of quantity and small-lot production.

A number of control systems for the machining of rotational parts and body parts, including a flexible automated control system for a system of machine tools with numerical program control (ASK-30), have been developed at the present time in the country.

The system is designed for semi-finishing and finishing of the base parts (frames, pedestals, tables and carriages) of vertical milling machines produced by the Ulyanovsk Heavy and Unique Machine Tool Plant (UZTS), and other parts similar to them, under conditions of quantity and small-lot production. The maximum dimensions of parts which can be machined are 1450 x 2200 x x 3600 mm and their maximum weight is 5 tons. Machining operations include: milling, finishing with "El'bor" [boron nitride abrasive material], boring, drilling and cutting threads.

The system (at the first stage) consists of a special multipurpose horizontal boring machine of the "machining center" type, transport and warehouse service lines, units for removing chips, an overhead traveling crane, a section for storing stock and parts, a section for loading parts and assembling satellite jigs, racks for storing elements of general-purpose assembly jigs, and an SM-1 computer, located in a separate area; the area occupied by the system is 1050 m^2.

Thirty different types of parts are machined in the system per year; startup batches have up to 40 sets; a set includes four parts; the number of operations is three; and the duration of operations is 2.25 to 11.5 hours.

In a section it is possible to machine also other parts similar in design. Prior to machining, stock must undergo marking out, rough machining, ageing and base-coat painting. Parts to be machined must be optimized for adaptability to streamlined manufacture, taking into account their fabrication on multi-operation machine tools with numerical program control.

The production-process part includes operation sheets for machining for representative parts, the technological requirements for parts to be machined, charts of sketches, and charts for the arrangement of tools, with an indication of cutting and auxiliary tools.

The organization part consists of organization of the work of the transport and warehouse system, the jig assembly section, the tool repair service, and lubrication facilities, and centralized control of the system.

The control system makes it possible to automate production planning and record keeping, dispatching control, and control of equipment and the tool service in real time, as well as the preparation and output of control programs (UP's).

The first subsystem which directively governs the operation of a section is planning of the section's work. For the purpose of fulfilling the main goal--making a monthly plan for the section--a program of operations has been planned which includes planning for three days the preparation for production, and 24-hour-shift planning of key and ancillary production (the choice of a 3-day planning period was due to the specific conditions). One of the main means of designing a schedule for the startup (production) of parts for three days is the calculation of priorities for the startup of parts for machining according to accepted rules of preference in a specific sequence: those in the process of being machined from the preceding shift; providing stock, tools and jigs--emergency parts; those with a maximum cycle length; and the first in the file of the intermediate plan for the section. The date for the production of batches of parts is taken into account in calculating priorities. In this connection, the production cycle is calculated after each operation and a determination is made of the time for starting the batch. All this helps to reduce backlogs and warehouse space required, and, this means, reduces the number of parts lying unused. Startup priorities can be corrected by means of input documents. This approach is justified since the use of manual labor for assembling (disassembling) a jig is reduced.

The result of the intermediate planning of ancillary production is output documents in accordance with which the planned stock, jigs and tools for a section are supplied by the respective services. As they arrive, the appropriate information, which is later to be used in planning key and ancillary production, is entered into the computer.

A logical extension of the intermediate planning of ancillary production is the formation of a schedule for the startup (production) of batches of parts for machine tools by a 24-hour period and by shift. It represents the basis of 24-hour-shift planning of the supplying of reference numbers for ancillary production to work stations.

Control of the operation of the transport and storage system for supplying (removing) stock is implemented in real time on the basis of the schedule file for the work station (machine tool). A trolley with a manipulator controlled by a computer in real time was selected as the main transport vehicle for the system.

The heavy weight of the stock determined the design of the between-operation storage units, in the form of massive assembly and storage stands, situated along one side of the transport route. The stock is placed on (removed from) satellite plates on the assembly stands. The trolley is sent to the stands after the loading (unloading) operation has been performed and after the appearance from them of an availability signal for the next loading (unloading). No operations on parts are performed on these stands, and the trolley can at any time come up to and take or put down a part.

Information regarding which part is on a satellite or whether it is free is read, and the movement and position of parts within the limits of the system are monitored from data transmitters on the satellites and from readers on stands and machine tools. Two control modes are provided for the trolley: by a computer, and by hand from a control console. Regardless of the mode, the transport cycle is broken down into two operations: "Go-Take" and "Take Away - Put Down." For the purpose of executing them, the transport address code and the direction of the trolley's movement are read out from the computer or console to the trolley's control unit. After completion of the cycle's operation, a "Trolley Response" signal enters the computer from this unit.

In controlling transport for a section, one key problem is the fulfillment of requests, arriving in the file, for the transport of parts. The requests answer the questions: what, from where and to where to transport? They are fulfilled according to priorities for the maximum utilization of machine tools. For implementation of control of the trolley-manipulator, it is necessary to learn its current state (free, operating, out of order) according to its file; what instruction ("Go-Take," "Take Away - Put Down") it is executing; to which module of the system it is moving; and the time of the start of execution of the transport cycle.

After the determination of startup priorities, a determination is made of the real operating time allocations for machine tools for each shift of the current 24-hour period and for subsequent 24-hour periods.

The priorities and allocations calculated represent the basis for calculating the schedule for the startup (production) of batches of parts for three days.

Taking into account the large capacity of magazines in machine tools (up to 50 tools) and the considerable weight of the tools, it is inadvisable to replace sets of them by stopping the machine tool after machining each batch. Therefore, the preparation of tools for machining an entire batch of parts is planned simultaneously for sets of tools and single tools.

The preparation of stock is planned for a period corresponding to the scheduling period for key production (three days), which helps to reduce the capacity of the warehouse and its cost.

Planning the preparation of jigs represents a complicated aspect of intermediate planning of ancillary production. This is due to the fact that they consist of elements of general-purpose assembly equipment which can simultaneously be part of various jigs. But their presence is limited. In this connection, a relatively reliable approach has been chosen for providing a section with jigs: A quantity of them is chosen to match the number of satellite plates in a section and so that there is enough of them to machine any part, without considerable readjustment, from the list assigned to the section.

For the purpose of precisely specifying the time for the start of the cycle, the transport control unit is used, which is operated over specific time intervals according to a timer or according to the "Trolley Response" signal arriving in the computer from the transport control unit. If the trolley is free and there are no requests for transport, the unit concludes its operation. If there is a request, then the one which has priority is fulfilled, or when priorities are equal, the one which arrives first. With availability of a module for loading (unloading), an arrangement is made for execution of the first operation of the transport cycle, i.e., "Go-Take." For this purpose, assignments are output by the computer to the trolley control unit. A signal for acknowledgement of the address code, which must agree with the one read out, enters the computer from the unit. In this case a signal is output for moving the trolley to the specific module. With this, the time of the start of the transport cycle is written in the file of the current state of the trolley. After completion of the cycle, the unit removes the fulfilled request from the transport request file, the file for the current state of the trolley is corrected, and the next request is accessed.

If the signals do not agree or no acknowledgement of the address code appears, then one of the diagnostic messages is output to the section operator and the trolley is transferred to the "Out of Order" state. With this, the transport control unit module concludes its work.

By virtue of the fact that the length of a system of machine tools for machining heavy parts reaches a few dozen meters and it is a complicated affair for a human being to keep track of the movement of the trolley, the necessity arose of keeping track of its serviceability automatically, with the subsequent output of information onto a display for the purpose of making decisions. For this purpose, a special module is used which is started only during execution of the transport cycle with the arrival in the computer of a "Trolley Response" signal, or from the timer with the absence of this signal. Keeping track of the serviceability of the trolley not only facilitates the work of a human being, but is also conducive to reducing the downtime of equipment and maintaining the flexibility and serviceability of the system by furnishing it with current information on the trolley for the appropriate correction of other files.

For the purpose of ensuring the serviceability of the control system in dynamics, a necessary condition is correction of the current state of the loading files (for machine tools and assembly and storage stands), and the file for the state of the trolley in loading. Here, if in unloading a module the code for its contents, when being compared, corresponds to the readings of the reader installed on the trolley, then the information is copied from the module's file into the trolley's file. When loading the module, the code for the contents in the file for the current state of the trolley is compared with the readings of the loading readers. If they agree, then information on the part is copied from the file for the current state of the trolley into the module's file. But if, in comparing the readings of readers with the information stored in files, any discrepancies are revealed, then diagnostic messages are output to the system operator's console and all transport in the section ceases.

In this case, for the purpose of clarifying the general situation in the section, the operator uses the unit for checking the state of the transport and storage system, which is called at the operator's request and is designed to perform the following functions: to poll the state of the data transmitters of the transport and storage system; to compare a read word of the state of a module with the corresponding entries in data files; to form messages for the section operator regarding the faulty state of the module and for transferring it to the "Out of Order" state.

Of considerable importance in the system for controlling the system of machine tools is the subsystem for controlling the supplying of tools, which includes planning of the preparation of tools for three days, 24-hour-shift planning of the delivery of tools to machine tools, keeping track of the life of tools in real time, and controlling the replacement of a single worn tool or set of tools when the machine tool is reset for a new part operation.

The preparation of tools is planned by sets for machining the entire planned batch and by the units included in the sets.

Sets are planned on the basis of the intermediate schedule for the section's work. The list of necessary tools contained in the set is gotten from the tool setup chart, and the number of them is determined analytically on the basis of the specified standard life of the tool. If the number of tools present in the storeroom is less or equal to the number specified, a message regarding the preparation of tools is not printed out. In other cases, a message is printed out regarding additional tool preparation and it contains the date of preparation, the number of the batch, the code for the set, and the number of the tool and the quantity of them.

Representing an extension of the intermediate planning of tool preparation is the 24-hour-shift planning of the supply of tools to machine tools in sets, with the tools included in them by type and number. For this purpose, the list of parts to be started for machining is accessed by the operator from the 24-hour-shift assignment file. In accordance with it, the set, with an indication of the list and the number of tools included in it, is copied from the intermediate tool preparation plan. As a result of processing,

an output document is printed in which are indicated the code of the machine tool, the code and number of the tool set, the number of tools, and the number of the machine tool's position. The setup person, in accordance with the intermediate preparation plan and the setup chart, sets up the tools by size and places them in the pockets of the container on the trolley in sequence according to the plan. Then he conveys them to the machine tools. Delivery is possible up to the time a batch is started. However, if the tool dispensing storeroom operates in one shift, supplying for the first shift is possible at its start, and for all remaining, at its end. The supplied tools are fed into magazines in the same sequence in which they were placed in the container.

In the process of machining of parts, tools wear out and the need arises of their timely replacement. A properly organized replacement system helps to reduce equipment downtime and to improve the quality of machined products. However, for implementing timely replacement it is necessary to keep relatively accurate track of the wear of tools or of the exhaustion of their life. For this purpose, a procedure has been developed and implemented for keeping track of tool wear by comparing the rated and current working time of a tool for a part operation. This method is implemented in the following manner.

A signal for the end of the part operation enters the computer from the machine tool. The life of the tool in the file for the machine tool's magazine is corrected on the basis of this signal. Then the next part for machining on the machine tool is displayed, based on the file for the current state of the machine tool. If it turns out to be a part of the same code as the previous one, a check is made of whether the machine tool has enough life left to machine it. If it is shorter than the machine operation time for the tool, then a message is output to the terminal regarding replacement of the machine tool, containing the tool's code and the code for the position of the machine tool's magazine. And if the code of the next part does not agree with the code of the preceding one, then a message is output to the terminal regarding replacement of the entire set of tools in the magazine, containing the code of the part and the code of the operation.

The approach described for keeping track of the life of tools is simple and sufficiently accurate and helps to shorten the time for readjusting equipment and to improve the quality of the machining of parts.

However, the wide spread in the life of tools can distort the accuracy of keeping track of their life and as a result not make it possible to achieve high machining quality. In this connection, it is necessary to introduce periodic inspections, as the result of which tools which have become blunt prematurely can be revealed.

An important element of the control system is the subsystem for group control of machine tools, which makes it possible after automated preparation to output a UP [control program] to the ChPU [numerical program control] unit directly from the computer without punched tape. The subsystem performs the following main functions: accessing the UP from a library formed on magnetic

disks; frame-by-frame output of the UP on the request of ChPU units; operation of ChPU in the "Retrieve Frame," "Speeded and Complete Program" and "Stop at End of Frame" modes; the recording and representation on the system operator's display of the state of machine tools in completing the UP; maintaining a journal of events in the process of the system's operation, and outputing it to a display and printing it; editing of the numbers of tool pockets in the text of the UP; automatic calculation of corrections in association with changing the length and diameter of a tool; entry of calculated corrections into the text of the UP, making it possible for the ChPU system to operate "without correctors."

The record keeping subsystem is, as it were, a generalizing control element. Its rationale reduces to two aspects: maintaining the system in a serviceable state, and obtaining information on the results of its functioning. Information is entered by two methods: by means of special data input consoles installed at work stations; and by program, from other functions of the control system. Information is output in the form of documents or onto a display. The following recordkeeping functions are implemented by means of this subsystem: of the arrival at the section of stock or parts after external operations, from the beginning of the month; of the passing through of batches of parts by operation from the beginning of the month; of finished parts put out by the section; of good and rejected parts by operation, which are in the storage area and have been prepared for the startup of parts; of sets of tools ready for work and installed on machine tools with an indication of their location; and equipment downtime for the section for a 24-hour period and cumulatively for the month.

The above-mentioned functions are implemented by means of a hardware system (KTS) and software (PO), whose makeup and essence reduce to the following:

The KTS makes it possible to edit and store UP's and to transfer them from the UVK [control computer system] to ChPU units, to transfer instructions to the transport and loading unit and to monitor its state, to receive messages from work stations as they arise, to output jobs for service personnel, to solve planning and recordkeeping problems, to print out the required documents, and other operations. The KTS is implemented on the basis of the SM-1 computing system and is supplemented by external working storage units, two displays, a printer with a keyboard based on the "Konsul" device, controlled-system interfaces (five modules), matching devices, and non-standard peripheral devices. Under the heading of the latter come specially developed input consoles and a data display.

The data input console is designed for the interchange of information between the operator of a section of machine tools with ChPU and a computer. The data display is designed for receiving, storing and displaying digital and position information required by the computer operator.

The software is divided into basic and application. The Real-Time Disk Operating System (DOS RV), Version 2, is used as the basic software. A standard file control system (SUF) for the DOS RV, making it possible to arrange for

sequential and random access to data, was used for the purpose of forming a data base and controlling streams of data.

The automated system described for controlling a system of machine tools with numerical program control was passed by an interdepartmental commission at the Ulyanovsk Heavy and Unique Machine Tool Plant. It is helping to improve labor productivity and the scientific and technical level of control of the process of machining heavy body parts.

The system can be circulated for similar systems by tailoring it to a specific production process.

In the future it is possible to improve the system for the purpose of forming a highly reliable "peopleless technology": to develop a diagnostic subsystem and to produce control programs by means of microprocessor equipment, and to increase the number of machine tools, improve their reliability and the speed of the system, etc.

8831
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APPLICATIONS OF SAPFIR-TP1 CAD SYSTEM VIEWED

Moscow MASHINOSTROITEL' in Russian No 7, Jul 84 p 13

[Article by B. A. Il'yenko, engineer: "Development of Computer Aided Design"]

[Text] The experiences of the Chelyabinsk imeni V. I. Lenin and Minsk imeni V. I. Lenin Tractor Plants indicated the efficiency of using NC lathes when machining round broaches; labor productivity increased and the quality of the product improved. However, the high labor-intensiveness of preparing control programs (UP) is an obstacle to the organization of the efficient manufacture of broaches and full loading of equipment. In the Chelyabinsk Tractor Plant this problem is solved by using minicomputers for UP preparation. Many enterprises of the sector use the YeS computer and universal systems for automatic preparation of UP (for example, SAPFIR-T27). However, preparation of the initial data takes a long time.

In 1983 the Khar'kov SPKTI [expansion unknown] for the development and introduction of automatic control systems for equipment with programed control developed the SAPFIR-TP1 systems for a YeS computer on a task assigned by the Minsk Tractor Plant. This reduced the volume of operational input data to a third, and used all the technological possibilities of the universal system. This system will be used to prepare UP to machine round and slot broaches on Models 16K20F3 and 16K30F3 NC lathes, although its design contains a minimum number of specialized units. Its nucleus is a universal system (for example, SAPFIR-T27) which can implement all functions, in particular develop UP technological documentation not only for making broaches, but also for other types of solid of revolution parts. Special modules around the nucleus implement the functions to control the system (this part is invariant with respect to the specifics of the article) and the function for adaptation to the special features of the article.

Designing specialized systems on the basis of a universal system has the following advantages. Conditions are created for rapid and easy development of a specialized system for any kind of products (shafts, pinions etc). This means that the proposed solution will eliminate large expenditures on developing rigid specialized systems on an industrial scale. Moreover, specialized systems created on the basis of a universal system have all of its wide functional possibilities -- from calculating cutting modes and automatically selecting the tools to prepare operational charts for the technological process which meet all the requirements of GOST 3.1424-75.

One great advantage of this type of system is the easy adaptation to a changed configuration of the article by correcting the conditional-constant input data with the means provided by the system. They also have the advantage of simultaneous future functional development since they are created on the basis of an independently developing nucleus -- the SAPFIR-T27 system. For example, in 1984, it is planned to develop this system further so that it will be possible to obtain adjustment charts on the graph plotter.

One shortcoming is the considerable volume of data in the specialized system of such a type (as compared to a rigid specialized system) which makes it impossible to utilize minicomputers in an autonomous mode. However, their work should be considered promising in YeS computer-minicomputer complexes, including in the YeS computer-subscriber points complex or an automated designer work position using a minicomputer because, in this case, there are advantages in the use of upper level machines and software for high quality solutions of complicated problems and lower level machines for the solution of small volume operational problems.

In this connection the operation of SAPFIR-TP1 systems using a YeS computer-AP-4 subscriber point complex is envisioned.

The SAPFIR-TP1 system version developed for the Minsk Tractor Plant has the following basic characteristics:

number of front and rear stem modifications -- 8;

possible number of combinations of front and rear stem modifications -- 256;

number of teeth and groove shapes, modifications -- 3;

number of modifications of tool motion trajectory shapes when machining -- 9;

number of teeth in section -- from one to three;

number of sections -- arbitrary;

the tool used for machining stems is a through cutter (GOST 20872-75 or GOST 20874-75) and in threading -- a chaser;

the tool for machining the cutting part of broaches is a special radial cutter;

the material of the cutting part of cutters is a hard T5K10 alloy;

cutting modes are as follows: cutting speed -- 70 to 120 m/min; feed -- 0.35 to 0.5 mm/rev.

The system receives control programs for making broach parts: stems and cutting parts. The input data coding language is alpha-numeric in the form of free entries.

The readiness of the SAPFIR-TP1 system, without counting transmission time for initial data and calculation results between the technologist and the computer, (because this time may vary within wide limits from 5 to 10 minutes to several days) is 1 to 2 hours on the average which satisfies multiproduct production facilities, including automated ones. The probability of erroneous situations in preparing initial data is reduced. The reliability of the system with previously prepared geometrical and technological solutions and initial data is determined only by the reliability of the computer. The remote processing mode using an AP-4 subscriber point, installed directly in the technologist's bureau, will make it possible to obtain stable results at the indicated time, independently of the location of the computer.

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TECHNOLOGY PLANNING AND MANAGEMENT AUTOMATION

TECHNOLOGY PLANNING FOR FLEXIBLE MANUFACTURING SYSTEMS

Moscow AVTOMOBIL'NAYA PROMYSHLENNOST' in Russian No 8, Aug 84 pp 1-3

[Article by A. D. Chudakov and B. Ya. Falevich of NIITavtoprom /Scientific Research Institute of the Technology of the Automobile Industry/ and the Andropov Aviation Technology Institute: "A System of Automating Planning and Document Production in Flexible Manufacturing Systems"]

[Text] The current stage of development of the machine-building industry features a new type of equipment -- flexible technological systems for machining. These systems are based on the use of machine tools with CNC, linked to a central controlling computer and an automated transport and stockpiling system. They make it possible to process an extensive product list and they create a base for conversion to unmanned technology. To improve the effectiveness of integrated operation of the system's equipment, the software of the central computer includes an applied program package directed toward the performance of automated planning functions, which, together with the operating documentation, makes up a system of operations-calendar planning.

These systems have long since been developed, and many of them are in various stages of readiness and adoption. As a rule they vary in the amplitude of the functions performed and in the principles and criteria for implementing them.

In particular, a system developed by NIITavtoprom and the Andropov Aviation Technological Institute and given the name Avtoplan has been designated for the flexible technological systems introduced into the automobile industry. It has already been put into experimental operation at the Mytishchi Machine Building Plant. Other developments of interest are: the SOPP-ASV /not further identified/ system of ENIMS /Experimental

Scientific Research Institute of Metal-Cutting Machine Tools/ for sections machining rotating elements; the OKP-ASK /not further identified/ system of ENIMS and the Andropov Aviation Technological Institute for sections machining chassis parts; and the systems of the Leningrad Institute of Aviation Instruments (LIAP) that have been adopted by the enterprises of Minelektrotekhprom /Ministry of the Electrical Equipment Industry/ and by the Leningrad Turbine Blade Plant Production Association.

Despite the variety of structural concepts of the systems mentioned and other similar systems, it is possible to isolate common features in the tasks (functions) they perform (see table).

System	SOPP-ASV	OKP-ASK	Avtoplan	LIAP
Operations planning of equipment operation	Automated	Semi-automated	Automated	Automated
Planning orders for tools and tooling	Not applicable	Automated	Automated	Automated
Adjusting operations plan between sessions	Not applicable	Semi-automated	Semi-automated	Automated
Long-range planning	Not applicable	Automated	Automated	Not applicable
Forecasting of production situation	Not applicable	Not applicable	Automated	Not applicable
Computation, storage and output of reference data	Automated	Automated	Automated	Automated

As the table shows, there are six of these common tasks. Let us examine them.

Operations planning of equipment operation. The essence of this task is: given the list of parts included in the planned assignment, the technological routing for each of them, and the assignment of units as to the sequence in which the operations of machining the parts must be performed and the time in which the operations must be completed, to set up a schedule for the performance of parts operations by the units of the complex. In other words, to switch from sequencing the operations of units for machining each part to sequencing the machining of parts for each unit.

To achieve a flexible response to a change in the production situation, and a corresponding increase of productivity it is

obviously necessary to attain the maximum efficiency of feedback, that is, to reduce the time intervals between a change in the situation and appropriate adjustment of the schedule. This requirement is met by a so-called dynamic planning schedule, in which a subsequent position of the schedule is determined immediately following the receipt of data on the results of implementing the preceding one. However, this type of planning is complicated by a number of organizational and technological difficulties, since at the beginning of a shift there is virtually no plan. Moreover, maximum product output is not always the goal that determines a planning task. As a result, all presently known systems operate on session planning. For ASV-type sections the minimum operational planning interval is a half-shift, and for the Avtoplan system it is a shift or even a day.

Adjustment of an operations plan between sessions of operations planning. In principle, revision of a plan, even with slight changes in the production situation, could lead to a new version of it quite different from the first one and requiring for its implementation a completely different set of blanks, tools and tooling. Formalizing the process of adjusting a plan is therefore very difficult. The SOPP-ASV planning system cannot solve this problem, and the data are stored on paper during a half-shift. In the Avtoplan system a man (dispatcher) makes the decision to adjust, and the control system of the complex's automatic cycle provides a capability for making adjustments in an interactive process through the display screen. But the adjustment function is most effectively performed by the LIAP systems: to compensate for disturbances in the course of production this provides for the use of internal production resources (schedule resources), that reside in the unavoidable planned downtime for equipment and the parts remaining between operations. The appropriate algorithm has been worked out and put into a suitable program.

Forecasting the status of production at the end of a given interval, that is, drawing up, together with the operations plan, an information report on the production situation at the end of a month, for example, by extrapolating the course of events on that day (fulfillment or nonfulfillment of the monthly plan at each position, shortage or surplus of time by groups of equipment, etc.). This task is accomplished only by the Avtoplan system.

Long-range planning, that is, verifying the theoretical feasibility of output plans, constructing batches and a plan for

their startup and completion together with drawing up the necessary command documentation and producing documents for ordering blanks. The results of long-range planning sessions are the basis for the operations planning session. In the SOPP-ASV and LIAP systems the initial data for operations planning as well as for adjustments are compiled by a staff member of the Planning and Dispatcher Service. The stage of long-range planning is fully automated in the Avtoplan system.

Planning orders of tools and tooling. In the SOPP-ASV system the toolmaker readies the tools and tooling in an ongoing half-shift on the basis of the assignment for the half-shift, which indicates time for readying tools and tooling, and the foreman does the monitoring. The system does not include data on task accomplishment, and they are not considered during planning. In the Avtoplan system, however, which is computed for production of great complexity and universal machining, the task of readying tools and tooling is incorporated into the system earlier (by three days), and the results of implementing it are included in the system and utilized in the next operations planning session.

Computation, storage and output of reference data are provided in all the systems under review. The output of documents on the implementation of a production program can be done either automatically on a set schedule or on demand.

The operation of planning systems in flexible technological systems is accompanied by documentation of the operations carried out and the production of instructional and current reference documents both for the system's personnel and management and for adjacent and system services. These documents are plans for the start up and production of parts; reports of orders of blanks; lists of batches being started; tasks of implementing operations to be performed; tasks on the makeup of tools and accessories; schedules (in tabular and graph form) of equipment operation and the movement of batches of parts; half-shift or shift assignments for all work places; schedules for accomplishing a planned task; reference and record data on the system's activities, including the equipment load factor, calculation of the quality of system operation, occurrence of a shortage of machine time, etc.

In the Avtoplan system the output of all the enumerated documents is automated, as is that of forecasting information reports. In all the other systems under review only that document production is automated that is related to operations

planning (with the exception of the occurrence of machine time shortages and similar forecasting tasks that none of the systems can perform).

The production of automated planning systems has been preceded by a great deal of work to set up the methodological foundations and principles for their construction. And this is understandable: at the present time we still do not have mathematical methods rigorous enough to permit us to find the optimum solution to planning problems under actual production conditions. Only a few simulation problems have been adequately researched (Johnson's problem, the travelling salesman's problem, and some others) that do not have practical importance but are regarded as sources of qualitative heuristic ideas. There are, however, various planning tasks that are accomplished by an automated system: in some cases the goal is to support the maximum output of equipment by a given system (the SOPP-ASV and OKP-ASK systems); and in others, to support a given output in given timeframes (the LIAP and Avtoplan systems).

Methods of compiling schedules are also selected in conformity with goals. In the SOPP-ASV system, for example, the method chosen is that of specific optimization, that is, the selection of a sequencing of operations for which the setting up of machine tools, tooling and tools will be minimized when converting from one operation to another. This version is original in that a computing and ratio matrix of the greater-less-equal type is normally used for the labor required for setting up. This makes this version highly effective in actual use.

For serial production jobs, especially when machining chassis parts at machining centers with automatic change of tool and accessories with the parts, setting up time is negligible relative to the time for machining a batch being started. It is necessary, moreover, to obtain a certain amount of hardware, which is determined by the presence of blanks, rather than the maximum, the magnitude of which is not known in advance. In the other automated planning systems, therefore, the principle of minimizing setting up time does not apply. Specifically, in the Avtoplan and OKP-ASK systems a heuristic method of drawing up schedules is used, which consists of having a computer simulate a process of gradual load on the machine tools. Therefore, for every machine tool freed from operation a batch is designated from those that require a given machine tool for a production process. The batch is selected with the aid of one or another rule of priority (method of selection): in the order batches

are acquired; by the maximum (minimum) duration of the operation; by the maximum (minimum) length of the incompleted portion of the process; by the law of random selection of a batch from a queue; by the location of a bottleneck (remote or nearby) in the production process. Methods of selection may also be used in combination.

One of the tasks performed by automated planning system personnel is to produce disruption-proof plans, that is, plans that can be carried out within the acceptable limits even when changes in the production situation come up. In the SOPP-ASV, OKP-ASK and Avtoplan systems this is accomplished with the aid of a procedure known as the principle of planning reliability. The essence of this is that the planned assignment for a work place can include only those plan items that are fully ready at the moment of planning to perform the appropriate operation. This means that the implementation of a planned assignment at a given work place in a given planning interval (shift, half-shift) will not depend on the implementation of planned assignments at other work places. Direct transfer of parts from machine tool to machine tool in conformity with the production process is therefore not allowed: it proceeds on the principle of bin to machine tool to bin. In the LIAP system, as noted above, planning reliability is ensured by planned equipment downtime, during which there is no machining of parts.

We therefore now have produced and in various stages of adoption genuinely effective automated planning systems for flexible technological systems. The Avtoplan system was developed for application to the problems of serial production in the automobile industry and responds in most of its indicators to the highest requirements made of these systems. (It is the only one that allows a batch of parts to be machined simultaneously at several consecutive operations of a production process.) The system may be used in primary production with a serial output of parts, that is, in such enterprises as BelAZ /Belorussian Automobile Plant/, GAZ /Gor'kiy Automobile Plant/ and others, and also in ancillary production in sections for press tools and dies, axle tools, pattern tooling, in-house machine tool building, etc. The work of improving it, however, must continue, especially to simplify software and documentation and to adapt it for future microprocessing by computer.

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TECHNOLOGY PLANNING AND MANAGEMENT AUTOMATION

AUTOMATED PLANT, PRODUCTION MANAGEMENT SYSTEM

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 5, May 84 pp 39-40

[Article by V. I. Aksenova and V. I. Belov, engineers: "Experience in the Creation of an Automated System for the Operational Management of Production Units"]

[Text] Experience in the development and introduction of a complex of tasks for the operational management of production (OUP) within the framework of an ASUP [Automated System for Production Management] shows how impossible it is to have effective computations without reliable initial information. Consideration must be given to the influence of many factors involving the production and economic activity of the entire enterprise upon the plan and course of production. So that management personnel can obtain reliable and timely information there should be an adequate model covering all levels of the hierarchical system: workplace, section (brigade), shop, enterprise, and the model should be incorporated into the technological sequence of performance, i. e. there should be provisions for an adequate person-machine system.

The organization of management at each specific enterprise (especially those with unit type production) is unique, since, as a rule, it is not planned from an engineering perspective. It is therefore practically impossible to change an existing system without additional labor, time and resources. It is also impossible to use standard program decisions (SPD) and applied program packages (APP) which have been developed elsewhere by others. Even APP specialized for a sector must be adapted to conditions at each specific enterprise. Algorithms should be sufficiently "flexible" and permit the system's operation during the transition period when only some sections or shops are automated, and later, as ASUP functions expand.

The introduction plan should include the development of the complete technological process and measures to stimulate the introduction of new methods and their inclusion by the system's users. Thus, in our opinion, the most serious problems in the development and introduction of automated production management are data timeliness, algorithm adequacy and person-machine system adaptability.

For the transition to the use of third generation computers, the ASU Department of the Tyazhstankogidropress [Heavy Machine Tool and Hydraulic Press] Plant (Novosibirsk) has developed a hierarchical management system for the main

production operations, which includes tasks in inter and intrashop management. The following tasks are for the generation of normative-reference and operational information: 0402 "Formation of MG403 Files", "Consolidated File", and MG40 "Name Directory"; 0419 "Accounts for Part Movement in Warehouses of Plan-Dispatcher Department (PDO)" and 0405 "Formation of Directory of Advance Norms".

File MG403 stores data on all parts and assembled units in an item, that is, it designates parts and their total number in all items. File MG400 stores parts designations and names. These files are initially formed from PDO plan specifications. Changes are made upon the notification of design departments.

Upon the production of new items for which there is YeSKD [Unified System of Design Documentation], the information will be compiled by machine based on data prepared by the production technical preparations subsystem (PTPS).

Task 0419 forms files MG402 and 0410. VMG402 stores the following information: designation of part, shop delivering semifinished part, shop delivering finished part, a running total of semifinished parts received since year's beginning.

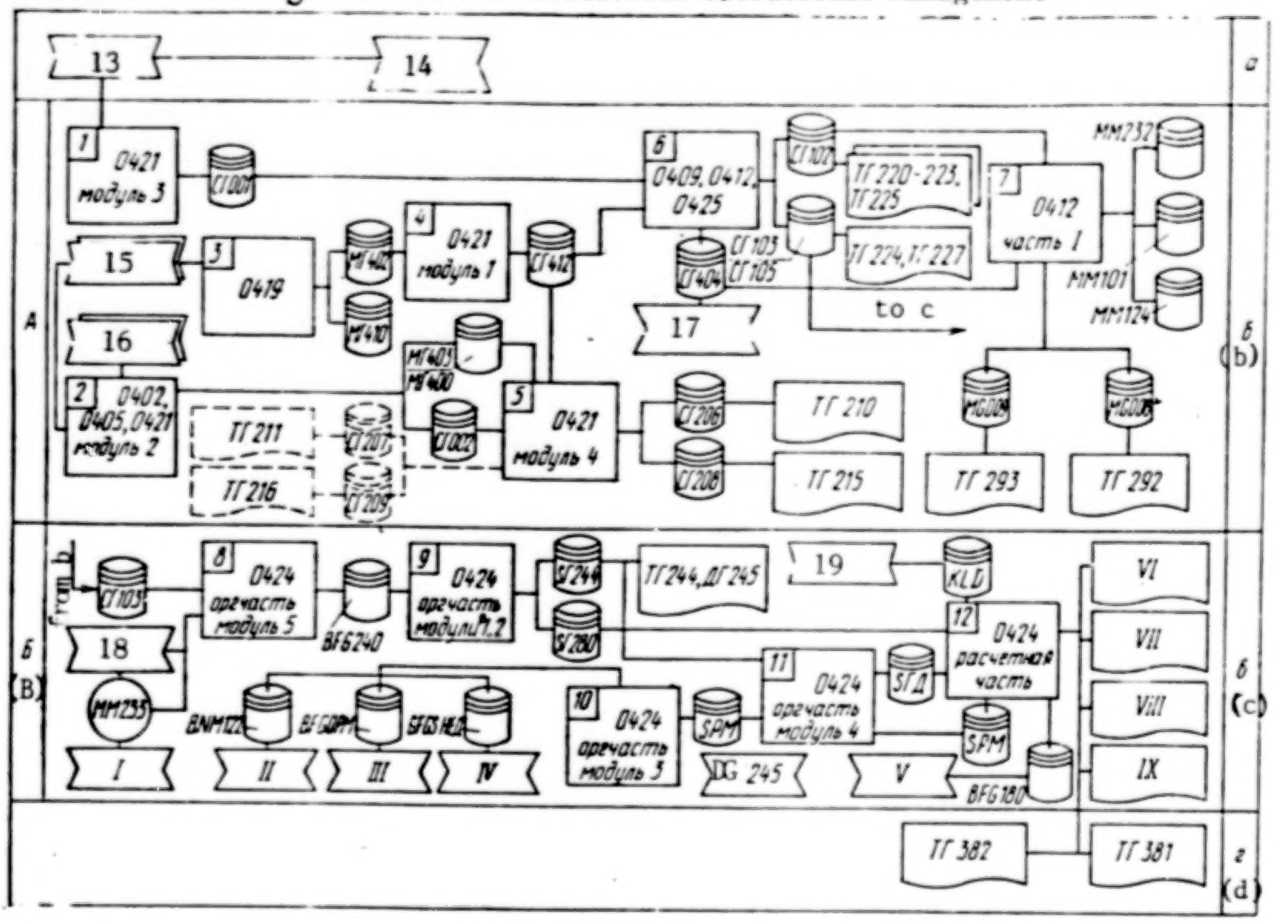
The file is initially compiled from PDO card files. Then daily changes are made in summaries and limit reports from warehouses also used to form the MG410 file. Task 0405 also includes leading norms, which are entered in the MG403 file.

Advance norms are calculated in the following manner: A critical path for the assembly of standard items is compiled. It is the basis for determining deadlines for the delivery of assemblies and parts and the compilation of assembly flowsheets which are enterted into a computer. The advance norms are entered into MG403.

The block diagram shows information linkages for the inter and intrashop management subsystem of the OUP. The complex of tasks for intershop operational management includes tasks 0409, 0412 and 0425, calculation of assortment targets for machine shops, blank preparation shops and the shortage of blanks for machine shop targets, it also includes task 0421, assembly shortfalls. These are calculated simultaneously and comprehensively. The parts target for the No. 6 welding and blank preparation shop is divided into 4 groups: welded parts, finished, sheet and round rolled items. Metal requirements are included. The estimation of metal requirements uses files MM232 "Parts' Norms for Materials", MM101 "Materials Assortment-Price List" and MM124 "Guide for Conversion from Plan to Accounting Units", formed in the PTPS [Production technical preparation subsystem].

The parts target for the No. 7 pig iron casting shop is divided into four groups: base, body, small and nonferrous casting. The assortment targets to the blank preparation shops are for No. 7 pig iron casting shop, No. 8 steel casting shop and No. 9 forge press shop. They are made by weight of pig iron, steel castings and forgings respectively. The capacity estimates for machine shop assortment targets are made in the intrashop planning task.

Information Linkages in Model of Production Operational Management



Key:

A. Intershop Management
B. Intrashop Management

a. First level - plant
b. Second level - shop
c. Third level - section (brigade)
d. Fourth level - work place

1. Task 0421 - calculate assembly shortfall, module 3 "Entry and Correction of Control Data"
2. Task 0402 - formation of "Summary Card File", 0405 - formation of directory of advance norms;0421, module 2 "Correction of Annual Schedule and Production"
3. Task 0419 "Account for Parts Movement at PDO Warehouses"
4. Task 0421, module 1 "Summation of Shop Results, Logical Control of Information"
5. Task 0421, module 4 "Calculation of holdovers at warehouses and shortfalls; printing of performance graph"
6. Set of tasks 0409, 0412, 0425 -- calculation of assortment targets for machine shops, blank preparation shops and shortfall of blanks for machine shop;
7. Task 0412, part 1 "Calculation of Metal Requirements for Blank Preparation Shop Program"
8. Task 0424, section module, organizational part, module 5 "Input of Part Plan"
9. Task 0424, section module, organizational part, module 1 "Check for Completeness of Technology File" and module 2 "Recoding of Parts Designations to Internal Code"

Key:

10. Task 0424 - Section model, organizational part, module 3; Preparation of Information on Work Place
11. Task 0424, section module, organizational part, module 4 "Logical Control of DG 245, preparation of SGD and SPM for Computational Part of Module"
12. Task 0424, section module, computational part
13. Control figures
14. Production schedule (quarter, year)
15. PDO card file, warehouse reports
16. Correction of annual schedule report
17. Mass of blanks, forgings, castings
18. Part target for norms
19. Calendar

TG 210. Assembly shortfall
TG 211. Assembly shortfall by date
TG 215. Machine shop shortfall
TG 216. Machine shop shortfall by date
TG 220-223. Parts targets for blank prep. shops
TG 2225. Blank shortfalls
TG 224, TG 227. Parts targets for machine shops
TG 292. Metal requirements for program
TG 293. Part report (upon request)
TG 244,245. Incomplete production
TG 381. Personal account
TG 382. Work place load schedule

I. Technology
II. Equipment group classifier
III. Planned capacity
IV. Monday reports
V. Heat treating norms
VI. Capacity calculation
VII. Section work forecast
VIII. Assortment target
IX. Supplemental tasks

Task 0421 calculates assembly shortfalls for each model of item included in the graph "assembly shops" and the "control figure" documents. Machine diagrams [machinogrammy] of shortfalls sorted out by part and deadline can be given in two forms. In the block diagram, the machine diagrams TG211 and TG216 are shown with dotted lines as they have not yet been sent to the shops; this part of the task is undergoing experimental operation. The time parameters for the intershop planning tasks are: the PDO gives the VTs [Computer center] control figures prior to the 20th of the month, all remaining calculations are made on computers not later than the 25th and transmitted to the PDO for approval by the production chief.

In constructing a model of intrashop management all sections are divided into four groups: multi-assortment section, multi-assortment section with multi-machine tool servicing, section with brigade organization of work on equipment, section with mixed type of work organization. Intrashop management is based on a model worked out for task 0424 and calculating capacity for groups of equipment which are part of a section's work schedule. On the basis of calculations, models for sections (brigades) produce machine diagrams: "Capacity Calculation", "Assortment Target", "Forecast of Section Work by Assortment", indicating the dates of the product's start-up and production. If the part is still incomplete by the month's end, then the number of operations remaining is indicated. The schedule is given in two forms: TG381 "Personnal Account", TG382 "Work Place Load Schedule". The input information in task 0424 includes: File SG103 (part target), entered from the set of tasks for intershop planning; MM233 "Labor Norms for Operations" comes from the PTP subsystem. There is also a small amount of normative-reference information. Planned capacity and data on workers and incomplete production

in a section comes from shops when it is necessary to make changes. We are now examining problems of the extent of automation of shop section accounting and other work, more rapid data transmission to the computer center, the possibility of information processing at lower levels on minicomputers, the transmission of aggregated information to higher levels, etc. We are also studying experience in the introduction of comprehensive ASU for sections using NC [Numerical control] and industrial robot linkages to ASU TP and organizational ASU.

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